making oat hay

chapter 8

credit Emma Leonard, AgriKnowHow

Hay making requires specialised equipment – mower, usually with in-built conditioners, rake, baler and handling equipment.

As a rule of thumb, if less than 200ha (4 to 5t/ha crop) of hay is to be made, then using contractors is the most cost effective, but owning your own equipment can give peace of mind.

One mower and one baler are required for about every 350 to 400ha of hay, while a rake can generally service 1000ha. If a spread of variety maturities is grown, less machinery may be possible.

If more than 300ha of hay is to be made, storage is desirable and then ideally two loaders are available – one in the paddock, the other at the shed.

Having the right amount of equipment helps to ensure hay making operations can be carried out at the best time.

A six tonne crop produces 10 bales per hectare and baling rates are about 60 bales an hour for large square bales. For one baler on 400ha that is two weeks (five hours baling/day) baling without any stops for rain or breakdowns.

Balers fitted with water tanks or steamers can add moisture to allow drier hay to be baled.

Cutting

Cutting is the first stage of the hay making operation. The objectives of the cutting operation are to:

- cut the hay so that it sits on the cut stems to promote rapid drying;
- produce a gently domed windrow that sheds water; and
- have a windrow wide enough to fill the full width of the bale pick-up. This may be achieved by tedding or raking rows into one just before baling.

With a mower, conditioner cutting, conditioning and the formation of a windrow are achieved in a single operation. Conditioning hay helps reduce curing time (see Curing).

The time of cutting in relation to plant growth stage, cutting height and direction, all impact on hay quality.

Cutting droughted cereals

The rules for achieving top quality hay from droughted cereals are slightly different. They usually have a much higher water soluble carbohydrate (WSC) level and to produce quality hay need to be cut before full head emergence. These crops should be super conditioned to help ensure this material is fully cured before baling (Testing moisture content).

The impact of growth stage on hay quality and quantity

The following information explains how the oat crop changes during the growing, maturing and grain fill periods. All growth stages relate to the Zadok's scale (see Chapter 2).

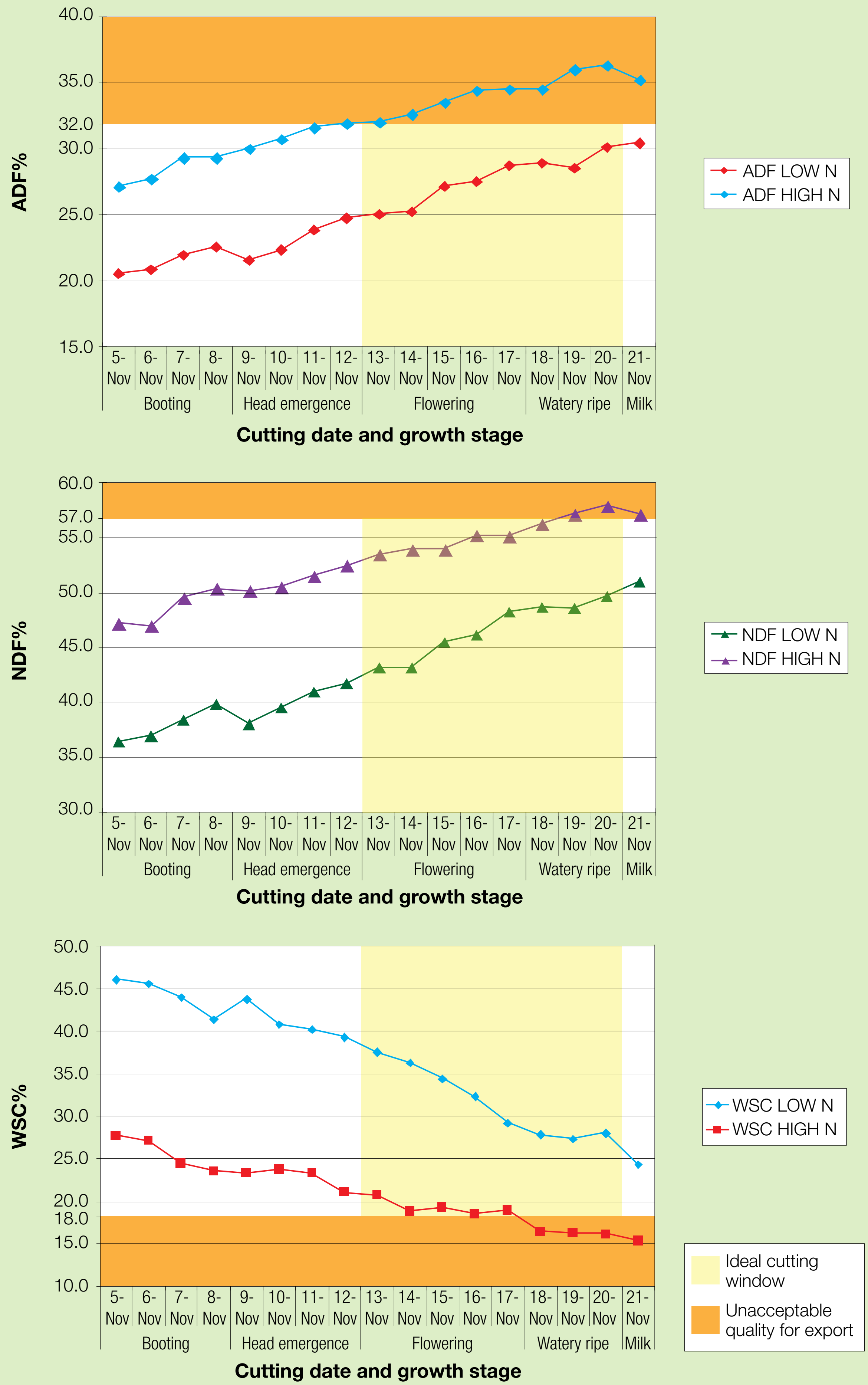

Figure 8.2 The change in fibre (neutral detergent fibre (NDF) and acid detergent fibre (ADF)) and water soluble carbohydrates (WSC) for a late maturing oat variety under a high and low nitrogen trial. The orange highlight indicates quality parameters that would not meet export quality standards.

Cutting oat hay between GS61-71 will maximise nutritional quality.

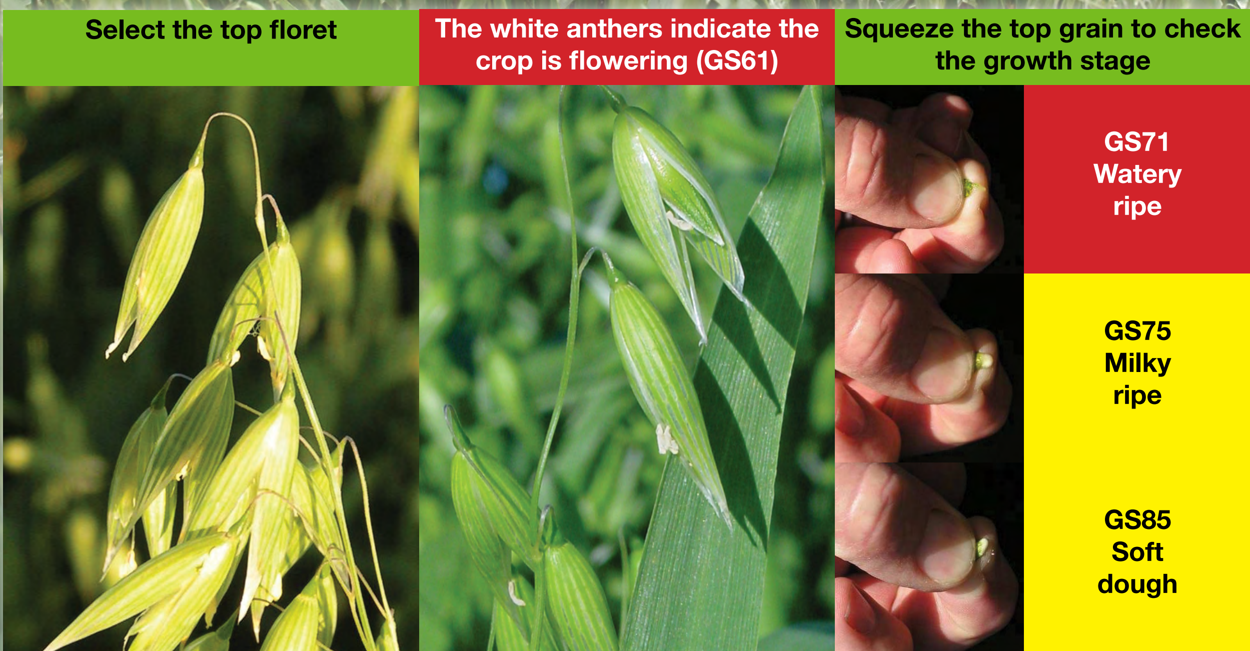

Figure 8.1 **Identifying when to cut – for quality oat hay cut between GS61 and GS71; after this quality will start to decline. Cutting too early, before the head is fully emerged, can add days to the curing time.**

credit Emma Leonard, AgriKnowHow

GS30 to 39 – stem elongation to flag leaf emergence

As the plant extends during stem elongation (GS30 to 39), photosynthate is used to form cellular structures such as lipids, hemicellulose, cellulose and lignin. The more mature an internode, the greater the proportions of lignin and cellulose and the lower the proportions of hemicellulose and lipids. Carbohydrates can be mobilised from older nodal and internodal tissue to support the demand of new growth. This is greatest if soil moisture is limiting and temperatures are too high for efficient photosynthesis.

GS40 to 60 – flag leaf emergence to flowering

The most rapid period of dry matter accumulation on a daily basis occurs from flag leaf emergence (GS39) until the end of boot stage (GS49). Dry matter accumulation can reach 200kg/ha/day for a high yielding crop growing with adequate soil moisture, good fertility and mild temperatures.

Daily growth rates are reduced as temperatures exceed 30°C or in very cool conditions. Hay crops can lose weight during hot weather or when under moisture stress. This is because respiration and transpiration losses exceed photosynthetic gains. Conversely, in good growing conditions WSC can increase to the end of the watery ripe stage.

From the time the panicle is fully extended (GS59), there is little addition of new photosynthate to the stems as this is now partitioned to the developing grain.

Maximum digestibility and lowest fibre content will occur between the boot and head extended stage (GS59).

Oats can flower before emerging from the boot, especially in moisture stress conditions or if a dwarf oat variety is grown. This situation results in GS61 occurring before GS50 to 59 is complete.

GS61 to 73 - flowering to milky dough - the ideal cutting period

The first three to seven days of grain formation culminate at the watery ripe stage (GS71). At this point, the panicle is fully extended but grains only contain clear, greenish liquid (Figure 8.1). Grain is not yet drawing heavily on carbohydrate from photosynthesis or storage. However, this changes rapidly as solids start to accumulate at the start of the milky dough stage (GS73).

As stems become more mature, they absorb water more quickly from rainfall. Hay cut after GS71 can deteriorate more rapidly after rainfall than hay cut at or around flowering.

GS74 onwards

After GS73, carbohydrate requirements for the developing grain are extreme and lignification of older stem material is accelerating. This results in an increase in the fibre fractions (as measured by NDF and ADF, Figure 8.2) and a reduction in WSC, which together result in lower digestibility. ADF and NDF content increase down the plant from the panicle to the base of the stem but there may not always be a similar pattern with WSC.

From flowering to soft dough (GS85), growth rates to a maximum of 175kg/ha/day have been recorded, so yield continues to accumulate.

As grain starts to ripen (GS90), overall digestibility of the plant increases and fibre fractions decrease because of the high starch content of the grain. If grain is removed, the remaining plant material has poor quality as mainly the fibre fractions remain.

Ripe grain in hay is undesirable to hay buyers because if grain is lost during conditioning, super conditioning or processing at a hay plant then the remaining hay is likely to be poor quality. The presence of grains also makes hay more attractive to rodents.

After flowering, the flag leaf will gradually senesce resulting in leaf discolouration. Senescence is likely to have started to occur in the F-1 and F-2 leaves, those directly below the flag leaf, several days earlier. If senescing leaves remain in the hay, they result in hay discolouration. In addition, fully extended flag leaves are prone to wind scorch although there are varietal interactions and invariably thick lush crops are more damaged. If scorching occurs on the flag leaf, it can look unsightly and hay can be downgraded. Scorching can occur on earlier emerging leaves but the presence of clean flag leaves is usually enough to overcome visual discolouration in the bale.

Impact of hour of cutting

Hay quality traits peak in the afternoon on cool to mild days and mid morning on hot days. This fact is important for research scientists but is usually not significant enough to alter the time of hay cutting at the farm level.

Curing time can be increased if the crop is cut wet. This is because moisture evaporates more quickly from the standing crop than from within the windrow. Ideally, allow dew or rain to evaporate before cutting.

Cutting height

Cutting higher reduces yield but can improve hay quality as the lower stems can be thicker, high in fibre and bleached of colour.

A rule of thumb is to cut at 15cm, the height of a drink can. High yielding crops and lodged crops may be cut slightly higher to ensure the weight of the windrow is supported off the ground. However, the following factors need to be considered when determining cutting height.

Contamination

Cutting height must be sufficient to prevent contamination from previous stubbles, soil, manure and other contaminants that may be on the soil surface. The aim is to present a windrow where the rake (if used) or the baler pick-up can clear the soil surface by 25 to 50mm. This generally requires a minimum cutting height of 12cm and preferably 15cm above the highest point between seeding rows.

Lodged crops

For high yielding, lodged crops, cutting height may need to be raised to 20cm. Height is adjusted to match crop fall and direction of travel. The aim is to ensure the crop is cut with a sufficient stubble length to allow hay to be picked up by super conditioners and balers without contaminants.

Lodged plants do not support the weight of a windrow because of the low angle of stems to the horizontal soil surface. Invariably, lodged plants are cut at differing heights depending on the direction of cut, the type of cutter used and the speed of operation.

If the weather is going to be fine from cutting to baling, lodged crops can be cut low, although feed test parameters would be expected to be poorer. However, if there is a risk of rainfall, lodged crops should be cut higher.

Cutting direction

When row spacing is greater than 12.5cm, cutting direction should be across the row. This can make working very rough so working at 45 degrees can be a good compromise. This will keep hay off the ground, improve air circulation and curing, limit spoilage and assist in efficient pick up by super conditioners and balers (see Figure 5.2). When cutting across seeding rows, cutting height may be slightly lower than when cutting in the same direction as seeding rows.

The best direction of travel in lodged crops often is determined by trial and error.

Super conditioners with roller pick-ups need the windrowed hay to be presented clear of the ground to allow efficient pickup of all cut hay. However, excessive length of the remaining uncut stubble can result in wrapping around the pick-up rollers causing blockages and lumpiness in the windrow. This can also result in plants with soil attached being pulled out of the ground and deposited in the windrow.

Cutting equipment

There are basically five types of hay cutting equipment. Some purely cut the crop while others cut and condition to reduce the curing time. The types are listed in Table 8.1, together with details of the drive options available. Additional equipment that may be required for the cutting/curing operation includes super conditioners, tedders and rakes; these are discussed in the section on curing.

Self-propelled versus PTO equipment

Power take-off (PTO) driven equipment can only cut round and round unless a swing arm machine is used. This must be taken into consideration when selecting seeding direction (see Figure 5.2). When cutting and conditioning with PTO machines, the drawbar and differential of the tractor must be able to clear the previous windrow; dragging equipment through a windrow can undo a good operation. If conditioning is a separate operation, the tractor operating the mower conditioner should not run over any of the previous windrow. Therefore, windrow size and shape may be dictated by tractor configurations when using PTO driven machines to avoid these issues.

Table 8.1 Types of mowers and available drive options.

	Self-propelled	Offset PTO or hydraulic	Swinging arm hydraulic
Rotary or flail slasher		✓	
Windrower	✓	✓	
Rotary/disc cutting mower conditioner	✓	✓	✓
Knife cutting mower conditioner	✓	✓	✓
All in one mower conditioner/super conditioner – knife or disc	✓	✓	✓

Swinging arm, hydraulic cutters offer the ability to cut up and back and reduce damage on headlands.

Triple or double deck mower set ups allow multiple windrows to be cut in a single pass. These consist of a front mounted mower, plus a single or twin mounted, or tow behind mower. Such set-ups in controlled traffic farming (CTF) systems enable hay to be cut without leaving the tramlines.

Self-propelled mower conditioners largely overcome these problems of disturbing or running over the previous windrow. Self-propelled mower conditioners can be used more easily to cut across or at an angle to the seeding rows, which helps keep the windrow off the ground. This is especially important as seeding row spacing increases. The greatest downside of self-propelled mower conditioners is the capital and annual depreciation costs.

Knife versus disc cutters

There is always great discussion over the virtues of disc and knife cutting machinery. Disc cutters have a greater cutting capacity than knife cutters and can be operated at greater speeds. Working speeds for disc cutters are stated as 20 to 30% higher than knife cutters, which can convert into cutting time efficiencies. This is often the reason for their widespread use. However, excess speed is one of the most common reasons for poor cutting and windrow presentation with both types of cutters.


A double deck set-up allows two windrows to be cut concurrently. In this CTF system, a second pass is required to cut the remaining crop. A triple deck system could overcome this requirement.

credit Emma Leonard, AgriKnowHow

Disc cutters have a greater cutting capacity than knife cutters and can be operated at faster speeds. Pictured is a disc and super conditioner, self-propelled mower.

Disc cutters produce excellent results, providing cutting blades are sharp and working speeds are not excessive (8 to 12km/hr) for crops of seven to 10 tonnes per hectare. Some operators have a preference for disc cutters when cutting lodged crops, because the discs have a lifting action on the cut hay. This may be an advantage but can result in variable cutting height depending on the direction of travel and the direction the crop is leaning.

Knife cutters must be sharp and when they are driven at moderate speeds the cut and windrow formation is excellent. Operating speed is particularly important in lodged crops where poor results are the most obvious.

Rotary or flail slashers

Flail slashers are not used to cut cereal hay and while rotary slashers can be used, the performance is inferior to disc or knife mowers. The cut hay is not conditioned and windrow presentation can be poor.

Windrowers

Windrowers are a compromise for hay cutting, as they do not condition hay. They are most suited to cutting straw or when hay yields are low where the extra width helps produce a windrow large enough to bale. Windrowers have high capacity but result in the cut stems of hay being predominantly presented lying in the same direction as cutting. This can result in more hay falling between the cut stalks and contacting the soil surface, making it difficult for the super conditioner or baler pick-ups to retrieve all the cut material. Raking windrows or the use of mixing belts can help overcome this problem but invariably produce an inferior windrow to that produced by a mower conditioner.

All in one mower conditioner/super conditioners

All in one mower conditioners/super conditioners execute the two operations in one, reducing the number of passes required to convert the standing crop to curing hay.

These machines are especially good when soil and atmospheric moisture are low (dry springs or late cuts), as hay is rapidly cut and cured in one pass. However, cutting lush crops with an all-in-one machine when the soil surface is moist and humidity is high, can create dense windrows and promote mould formation. In this situation, additional removal of free moisture from the crop by raking or tedding may be required.

Ensuring good set-up as detailed by the manufacturer and not working too fast, especially in heavy crops, are important to achieve a quality result.

Curing

For every one tonne of hay baled, approximately three tonnes of water needs to be removed by evaporation. Dew can add an additional one to two tonnes of water per hectare.

Curing speed is affected by environmental, management and mechanical factors (Table 8.2). An understanding of each of these factors can help improve the quality of hay that is baled, stored and eventually fed out.

Table 8.2 Factors that positively affect the curing of hay.		
Environmental factors	**Management factors**	**Mechanical factors**
Clear skies	Crop maturity – younger faster	Tedding
Warm temperature	Leaves faster than stems	Conditioning
Low humidity/no rain	Time of mowing	Windrow inversion
Moderate wind speed	Well formed windrow	Raking

Environmental factors

Solar radiation, temperature and wind combine to drive the speed of the curing process (Figure 8.3). However, the speed of curing is also influenced by humidity and rain.

The faster the curing process generally the better as hay quality continues to decline during the curing process. This is because the cut plants respire while their moisture content is above 30%. Respiration is an important part of the drying process but at the same time, plant sugars are broken down resulting in a loss of quality and dry matter. Respiration losses increase rapidly when temperature is above 20°C and can result in dry matter losses of over 15%, compared to dry matter losses of between 2 to 8% when curing occurs in cooler conditions.

Long curing periods make the hay crop more vulnerable to weather damage, resulting in loss of soluble nutrients, bleaching and the development of moulds, stains and taints; all of which impact on hay quality.

After heavy rainfall, leaching can cause dry matter to reduce by 20% of the original crop dry matter. Rain can also cause leaf shatter and regrowth to occur in the windrow.

The latter not only increases the curing time but the potential for green matter to be included in the bales, increasing their moisture and likelihood of moulds developing and even self-combustion.

Generally, the greater the amount of rain, the longer its duration, the lower its intensity and the later it occurs in the curing period, the greater the loss of dry matter and hay quality (Figure 8.4).

Cutting hay on to wet ground should be avoided as the moisture from the ground will move up through the drying hay increasing curing time.

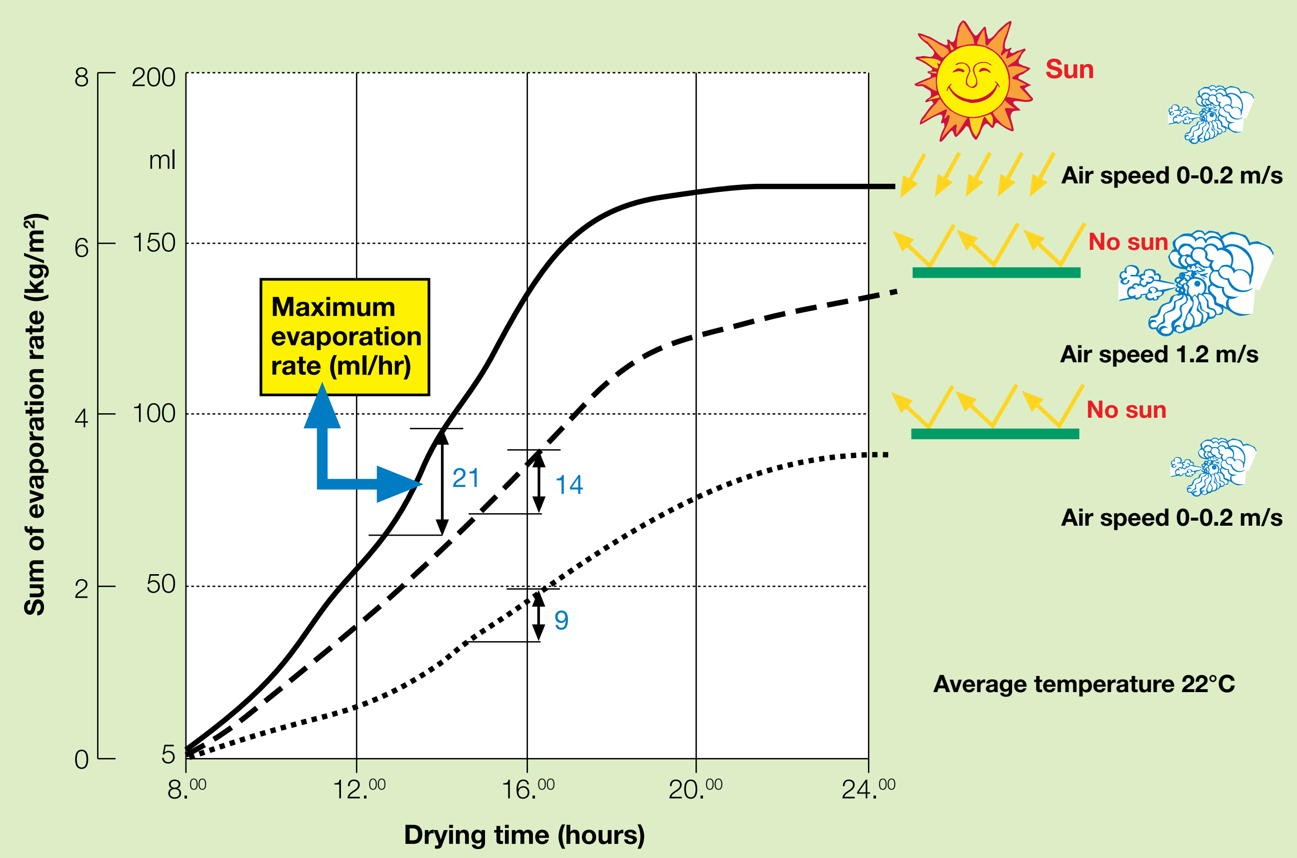

Figure 8.3 Influence of solar radiation and airspeed on evaporation rate of water – *source W. Dernedde 1980.*

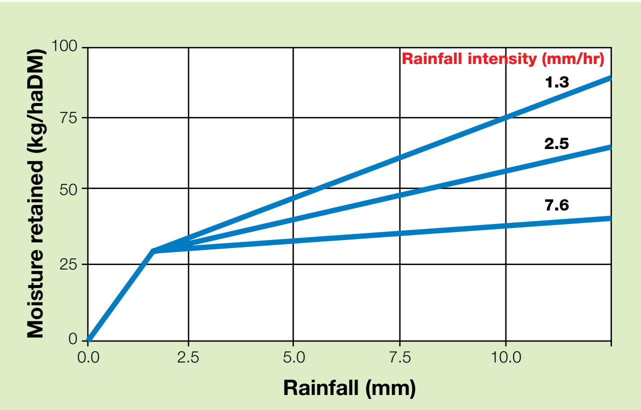

Figure 8.4 The impact of rainfall amount and intensity (rate) on retention of water by mown plants – *source Pitt and McGechan 1989.*
Generally, the greater the amount of rain, the longer its duration, the lower its intensity and the later in the curing period, the greater the loss of dry matter and hay quality. Hay cut after GS71 can deteriorate more rapidly after rainfall than hay cut at or around flowering as maturing stems absorb water more quickly.

Management factors

Of all the management factors, windrow formation has the greatest influence on the curing time. Younger plants cure faster than older plants and leaves dry faster than stems but these factors are influenced by conditioning and windrow formation.

Cutting after dew has dried helps reduce curing times but overall the impact of temperature and wind conditions drives the curing process rather than the hour of cutting.

Windrow shape is a compromise between minimising drying time and minimising weather damage and water entering from moist soil.

A wide, evenly domed windrow allows more penetration of wind and sunlight and sheds rain to maximise the speed of curing and minimise weather damage.

Windrow dimensions may vary between export and domestic hay. A less dense windrow cures more quickly as the proportion of air to cut material is greater. However, a less dense, wider windrow has a greater surface area that can result in more sun bleaching and colour loss. For the export market where colour is a determining factor in the price paid for hay, a narrower windrow is preferable.

The windrow width should be closely matched to the width of the bale pick-up to ensure all material is picked up and the accumulation chamber in the baler is evenly filled. If windrows are too narrow, then the baler operator needs to swerve the baler from side to side as it travels along the windrow to keep the chamber evenly loaded.

Excess cutting speed is often characterised by bunching in the windrows or the formation of a V or U shape in the centre of the top of the windrow. The presence of this windrow shape channels water from rainfall into the centre of the windrow rather than allowing it to be shed to the sides. Where higher operating speeds are required, care should be taken with the shape of the windrow and adjustments must be made to the delivery chute to avoid poor windrow presentation.

Mechanical factors

Tedders

Tedders are commonly used for pasture hay, sometimes used for domestic hay and less commonly used for export hay. Tedders increase the surface area of the hay by spreading a windrow in a thin layer, thereby speeding up the drying process. However, the increased surface area may result in higher levels of sun bleaching.

Tedding hay to improve drying times is less recommended for export hay as it increases the opportunity to pick up soil and other contaminants. Not tedding must be balanced against the opportunity to reduce curing time and maintain feed test quality. Their use for export hay has usually been to spread windrows that have been rained on, to aid the drying process and reduce spoilage.

Conditioning

Approximately 30% of stem water is lost through the leaf, leaving 70% to be lost through the stem and florets.

Conditioning helps accelerate the loss of stem water squashing and crimping the stems and leaves. Super conditioners, which can be run as a separate pass, operate at much higher roller pressures than mower conditioners and provide continuous squeezing pressure crushing nodes and florets rather than crimping stems. Some operators with large hay programs only super condition the first few paddocks to help initiate baling as soon as possible.

Some operators believe super conditioning is essential if drought cereal crops are cut with windrowers or harvester fronts as the panicle is often still in the boot and hard to dry down without crushing.

Water evaporates at 100 litres per tonne per hour, from open stomata on the leaf surface. Squashing stems and abrading leaves by conditioning increases the rate of water loss to between 150 to 180 litres per tonne per hour.

As a rule of thumb, super conditioners can reduce drying time by about 50% compared to normally conditioned hay, however the crop is more vulnerable to rain damage.

A separate pass of a super conditioner after rain can help accelerate curing. The best results are achieved when rain occurs shortly after cutting and no further rain falls.

In good drying conditions, super conditioning can result in hay becoming too dry resulting in poorer bale formation. Therefore, drying conditions and baling equipment must be considered before super conditioning (refer to Bale formation).

Tow behind super conditioners can have roller or finger pick-ups. Generally, roller pick-ups can be operated at higher speed but finger pick-up machines are preferred when the hay is close to the soil surface (approximately 10 to 20mm) for crops on wide row spacing.

Rollers differ in pressure and the degree of fluting from smooth to fine dense flutes. Super conditioners with rollers operating at different speeds or fluted rollers should not be used on drier hay as they can cause ‘chaffing’. This type of super conditioner should probably be used closer to cutting time. Conversely, high pressure roller super conditioners can cause excess moisture loss and subsequent mould formation if used too soon behind the mower.

The windrow formed by a super conditioner should have the same domed shape as a mower formed windrow and should not be run over during the formation.

credit Emma Leonard, AgriKnowHow

Windrow formation has the greatest influence on the curing time.

A wide, evenly domed windrow (left) improves penetration of wind and sunlight and sheds rain to maximise the speed of curing and minimise weather damage. Excess cutting speed is often characterised by bunching in the windrows or the formation of a V or U shape in the centre of the windrow (right) which channels rainfall into the centre of the windrow.

Super conditioned hay showing crimping and some squashed nodes, both of which help to reduce curing time.

Windrow inverters

These gently lift and invert the windrow on to dry ground but are generally not found to be as effective as tedders or super conditioners.

Rakes

Raking exposes hay from the centre of the windrow to lower humidity, higher temperatures and sunlight on the outside of the windrow, helping to speed drying. A rule of thumb is that each raking reduces the time from cutting to baling by 10 to 15%. While raking helps reduce curing time, this may come at the expense of some leaf loss, sun bleaching and increased risk of introducing contaminants.

Raking can also aid drying after rainfall but it appears the results are best if the rainfall is relatively light. If the top of the row is dry but the bottom remains wet, then turning the row onto the dry inter-row can help speed drying.

Powered or finger driven rakes are used to combine windrows to create a suitable volume of hay for baling and to reduce inactive baling time. It is cheaper to rake hay than operate a baler with the front only partially filled.

Baling

Baling hay is a crucial part of the hay making operation. Attention to detail is required when assessing hay moisture, atmospheric conditions and checking machinery performance. Bales must be dense and well formed to withstand transport or storage.

Choice of baler

The choice of baler, high density/large squares, round or small squares, will firstly be dictated by market requirements (see Chapter 3) and secondly by the storage, handling and cartage needs. Differences in baler performance usually fall into third place.

Moisture content

Hay baled at over 18% moisture is at risk from damage by mould developing in the bale and spontaneous combustion.

Export markets prefer baled hay with a moisture content of less than 14%; some exporters' standards are as low as 12% moisture. At these low moistures the risk of spontaneous combustion during storage is minimised (see Table 9.1). At these low moisture levels there is a lower risk of condensation occurring during transit that ultimately drips off the container roof back onto the hay, creating wet patches and encouraging mould formation.

High density bales do not dry readily because of low air exchange rates and the insulating qualities of hay. Consequently, bales of 18% moisture may take many months to dry to an acceptable moisture content.

Check with hay buyers before applying any hay additives that support the safer storage of higher moisture hay.

Gazeeka is an Australian designed and manufactured moisture sensor that can be installed in large square balers. This equipment allows bale moisture to be monitored on-the-go and the early identification and segregation of high moisture bales.

Testing moisture content

It is important to test moisture content before baling.

A moisture meter can adequately measure moisture in a tightly bound handful of hay.

The same handful of hay can be wound rapidly in a circular motion to produce shearing. If by three turns the hay does not break, it may not be sufficiently cured.

Open a stem above and below the node. The inner most leaf inside the stalk can still be moist when the outer stalk appears totally dry.

The most reliable test is to squash the nodes on a dark, metal surface with a hammer. Check for moisture underneath a squashed node - uncured, nearly cured, fully cured (L to R). If the panicle is still in the boot, squash the boot and assess.

Test bales with a moisture meter. If higher moisture bales exist, these are best stored separately and moisture monitored regularly.

If there is still concern over bale moisture content, test the moisture in 10 bales which have been left for 12 to 24 hours after baling. Moisture should be under 14% to continue baling.

Well made, dense square bales retain their shape which is crucial for transport and storage.
Bales produced from a high density baler (left) have eight strings and typically weigh over 700-850kg. Traditional large square bales are secured by six strings and weigh between 500-600kg (right).

Bale formation

Poorly made bales will collapse resulting in handling difficulties and wastage. Balers must be set up to produce dense bales and twine should be matched to bale densities as bales with broken strings are unacceptable to the market. The use of net wrap for round bales helps overcome this problem. Matching the width of the windrow and bale pick-up helps in the production of evenly shaped bales.

The introduction of high density bales has increased bale weight from about 600kg to up to 850kg per bale. This is helping reduce transport and storage costs (see Figure 9.1) as more bales can be loaded into the same area. At publication, the Australian Fodder Industry Association (AFIA) is working with regulatory authorities to address transport issues relating to high density bales.

For large square bales, hay is picked up and fed by finger tines into the accumulation chamber. High density square bales can have knife cutters after the pick-up that chop the hay into short lengths which can be packed more densely. Check with hay buyers if they require high density bales to be chopped.

For both types of baler, the aim is to maintain the uniformity and density of hay in the accumulation chamber, so that it packs evenly into the bale chamber. Slower ground speeds result in the hay being more densely packed in the accumulation chamber, which can help overall bale density.

When the accumulation chamber is full, the hay is discharged into the bale chamber as a distinct wad or biscuit of hay. For well formed dense large square bales, successful baler operators indicate setting machines to produce 38 to 40 of these wads per bale, while other industry participants suggest 32 is

satisfactory. Any less and the bale can lack density and be poorly shaped. Any more exerts excess pressure on strings, increasing the chance of breakage.

Hay that is baled too dry has lower density in the accumulation chamber and does not retain its shape in the bale chamber. This can result in poorly shaped, light bales with excess pressure on strings.

Innovations to allow the baling of drier hay or baling when atmospheric conditions would normally stop baling include the use of metal wedges in the bale chamber; extended bale chambers; and water or steam sprayed on to the sides of the bale in the chamber to increase the friction between the bale and the chamber.

If hay is too damp, it feeds unevenly and creates areas of high density. Excess moisture cannot be released from the bale and wet patches can occur.

Square bales can be discharged directly from the rear of the baler or can be turned 90 degrees so when discharged, the bale rests on the cut side, rather than on the strings. This offers the advantage that the less dense part of the bale, which dries more quickly, is exposed to soil moisture and rain. If this face is damaged by moisture, it can be removed by a guillotine.

Several bale stacking systems are now on the market, some directly towed by the baler, others stack as a separate operation.

Making round hay bales is generally more forgiving than for large squares as bale density is lower. This allows hay to be baled at higher moisture with lower risk of spontaneous combustion (see Table 9.1) and a much greater ability to dry due to air movement and evaporation within and between bales. However, bales should still be robust and should not lose their round shape after being discharged from the baler.

Sampling and tagging

The accuracy of nutrient analysis depends on the sample sent to the laboratory. It is critical that the sample represents the average composition of the hay 'lot' sampled, otherwise the laboratory tests will not be useful.

A 'lot' is defined as hay taken from the same cutting, at the same stage of maturity, the same species (pure or mixed) and variety, the same paddock, and baled within 48 hours. Other factors influencing the definition of a 'lot' include rain damage, weed content, soil type, treatment after cutting and storage implications. A 'lot' of baled hay should not exceed 200 tonnes.

Sampling hay

Representative hay samples can only be obtained with a probe or core sampling device. A couple of handfuls or a 'flake' from one bale are not adequate. Corers are commercially available in Australia. Alternatively, corers can be made using 32mm steel tubing, and should be at least 450 to 500mm long with a slightly scalloped, sharp cutting edge. Corers are driven by a hand brace or an electric drill (where practicable). Some cordless drills may not be suitable if they lack power or turn too fast. A portable generator is useful and can be justified if many samples are taken.

Sample size should be confirmed with the hay buyer or testing laboratory. More details about sampling by bale type are found on the AFIA website (www.afia.org.au).

Small square bales

Sample between 10 and 20 small square bales, selected at random from the 'lot'. Take one core from each bale selected, probing near the centre end bale (small face), at right angles to the surface. Ensure that the corer does not become hot. Combine all cores into a single sample in a bucket, and mix thoroughly. The whole sample should be kept intact and not subdivided.

Large round or square bales

Sample between five and 10 large bales, selected at random. Take one core from each side of all bales selected, probing at right angles to the surface at different heights. Combine all cores into a single sample in a bucket, and mix thoroughly. The whole sample should be kept intact and not subdivided.

Sample handling

Immediately after sampling and mixing, the final hay sample should be placed in a robust (preferably 'press-seal') plastic bag and tightly sealed to exclude air. This is to ensure that the laboratory report of dry matter will approximate the dry matter content of the 'lot' when sampled, and to minimise aerobic spoilage.

Samples must be delivered to the laboratory as quickly as possible after being taken. Avoid mail delays over the weekend by posting samples early in the week. Ensure that the laboratory's instructions for labelling samples are closely followed and all the required details on the sample submission sheet are completed.

Identification and traceability

Hay exporters are required to demonstrate sampling, testing and tracking of hay in the export pathway. Speak to your hay buyer about identification requirements.

Individual bale identification helps hay exporters track hay along the export pathway.

credit Emma Leonard, AgriKnowHow

A ute mounted hay sampler as used by many export hay buyers.